WHAT IS CLAIMED

1. A method of wireless differential communication, the method comprising:

generating a plurality of baseband signals based on Cayley-encoded input data;

modulating said baseband signals on a carrier to form carrier-level signals; and

transmitting said carrier-level signals from at least one antenna.

2. The method of claim 1, wherein each baseband signal is also based on a previous baseband signal that corresponds to a previously-transmitted carrier-level signal.

3. The method of claim 2, wherein

said transmitting step transmits from a multiple antenna array;

each baseband signal includes one or more sequences, in time, of complex numbers, each sequence to be transmitted from a respective antenna of said multiple antenna array; and

each baseband signal is representable as a transmission matrix in which each column corresponds to one of said sequences and represents a respective antenna and in which each row represents a respective time segment.

4. The method of claim 3, wherein said generating step generates each transmission matrix based upon said input data and a previous transmission matrix representing previously transmitted baseband signals.

5. The method of claim 4, wherein said set of data matrices is a set from a plurality of sets providing a highest transmission quality out of said plurality of sets.

6. The method of claim 4, wherein, for a total number of bits of data to be transmitted, said generating step includes:

breaking said total number of bits into same-sized chunks;

mapping each of said chunks to take a value from a predetermined set of real values to obtain a scalar set;

determining a Cayley-Differential ("CD") code based upon said scalar set; and

determining said transmission matrix based on said CD code.

7. The method of claim 6, wherein said step of determining said CD code includes calculating said CD code, V, according to the following equation:

$$V = (I + iA)^{-1}(I - iA)$$

where

$$A = \sum_{q=1}^{Q} \alpha_q A_q$$

and V is a unitary matrix, and where α_q is a scalar, I is the identity matrix and A_q represents an element from a set of fixed M X M complex Hermitian matrices.

8. The method of claim 7, wherein said set, $\{A_q\}$, of fixed M X M complex Hermitian matrices is determined by maximizing over $\{A_q\}$ according to:

$$\xi(V) = \frac{1}{M} E \log \det(V - V')(V - V')^*$$

where $A' = \sum_{q=1}^{Q} \alpha'_q A_q$ and $\alpha \neq \alpha'$.

9. The method of claim 8, wherein said { A_q } is stored in the memories of both the transmitter and a corresponding receiver before said data to be transmitted is transmitted.

10. The method of claim 6, wherein:

said total number of bits equals R*M, where R is the rate in bits per channel use and M is the number of transmit antennas;

said number of chunks is Q, where Q represents the number of degrees of freedom; and

each chunk is R*M/Q bits in size.

11. The method of claim 6, wherein said predetermined set of real values, known as A, is determined according to the following equation:

$$d = -\tan(\theta / 2)$$

for every θ in the set {θ} = {π/r, 3π/r, 5 π/r, ... (2r-1) π/r}, where $d \in \mathrm{A}$, r is the number of elements in said A and $r = 2^{R*M/Q}$.

12. The method of claim 11, wherein said A is stored in the memories of both the transmitter and a corresponding receiver before said data to be transmitted is transmitted.

13. The method of claim 4, wherein said step of determining said transmission matrix includes calculating said transmission matrix, S_τ, according to the following equation:

$$\mathrm{S}_\tau = \mathrm{V}_{Z_\tau} \mathrm{S}_{\tau\text{-}1}$$

where V_{Z_τ} is generated in part according to said CD code and $S_{\tau-1}$ represents the previous transmission matrix.

14. A method of wireless differential communication, the method comprising:

receiving receive carrier-level signals, each of which is formed from at least one transmit carrier-level signal transmitted from at least one transmitter antenna passing through a channel, using at least one receiver antenna;

demodulating said receive carrier-level signals to recover a plurality of Cayley-encoded receive baseband signals; and

processing said receive baseband signals to obtain data represented thereby.

15. The method of claim 14, wherein each receive baseband signal depends on said data as encoded therein and a previously-received receive baseband signal that corresponds to a previously-transmitted carrier-level signal.

16. The method of claim 15, wherein each receive baseband signal includes one or more receive sequences, in time, of complex numbers; and

wherein each receive baseband signal is representable as a reception matrix in which each column corresponds to one of said receive sequences and represents a respective receiver antenna and in which each row represents a respective time segment.

17. The method of claim 16, wherein said transmit carrier-level signals were formed from a plurality of transmit baseband signals, each transmit baseband signal including one or more transmit sequences, in time, of complex numbers, each transmit sequence having been transmitted from a respective antenna of a multiple antenna array, each transmit baseband signal being representable as a transmission matrix in which each column corresponds to one of said transmit sequences and represents a respective transmit antenna and in which each row represents a respective time segment, each transmission matrix being based on a transmission matrix representing a previously transmitted transmit baseband signal and input data.

18. The method of claim 15, wherein said processing step includes searching a predetermined set of real scalar values to assemble a set $\{\alpha_q\}$ that minimizes one of the following equations:

$$\hat{\alpha}_{ml} = \arg\min_{\{\alpha_q\}} \left\| (I + i\sum_{q=1}^{Q} \alpha_q A_q)^{-1} \left(X_\tau - X_{\tau-1} - \frac{1}{i}\sum_{q=1}^{Q} \alpha_q A_q (X_\tau + X_{\tau-1}) \right) \right\|^2$$

or

$$\hat{\alpha}_{lin} = \arg\min_{\{\alpha_q\}} \left\| X_\tau - X_{\tau-1} - \frac{1}{i}\sum_{q=1}^{Q} \alpha_q A_q (X_\tau + X_{\tau-1}) \right\|^2$$

where A_q represents an element from a set $\{A_q\}$ of fixed M X M complex Hermitian matrices, X_τ represents a presently-received distorted version of the presently transmitted matrix of data and $X_{\tau-1}$ represents a previously-received distorted version of the previously-transmitted matrix of data.

19. The method of claim 18, wherein said $\{ A_q \}$ is stored in the memories of both the receiver and a corresponding transmitter the before said data to be transmitted is transmitted.

20. The method of claim 18, wherein R*M bits of data are received, where R is the rate in bits per channel use M is the number of transmit antennas, the method further comprising:

mapping each element of said $\{\alpha_q\}$ into corresponding R*M/Q bits, where Q represents the number of degrees of freedom, to get Q chunks; and

reassembling said Q chunks of said R*M/Q bits to produce the R*M bits of data that were transmitted.

21. A method of wireless differential communication, the method comprising:

generating a set, $\{A_q\}$ of fixed MxM complex Hermitian matrices for which $\xi(V)$ satisfies a maximization criterion and $\xi(V)$ is defined by the following equation:

$$\xi(V) = \frac{1}{M} E \log \det(V - V')(V - V')^*$$

where $V = (I + iA)^{-1}(I + iA)$,

$$V' = (I + iA')^{-1}(I + iA'),$$

$$A = \sum_{q=1}^{Q} \alpha_q A_q$$

$$A' = \sum_{q=1}^{Q} A_q \alpha'_q \text{ and } \alpha \neq \alpha',$$

where A_q is a fixed MxM complex Hermitian matrix and each α_q is real-valued scalar from a predetermined set thereof.

22. The method of claim 21, further comprising:

performing at least one of

generating a plurality of baseband signals based on input data encoded as a function of said $\{A_q\}$, and

processing a plurality of encoded receive baseband signals to obtain data represented thereby, said receive baseband signals having been encoded as a function of said $\{A_q\}$.

23. The method of claim 21, further comprising:

storing said $\{A_q\}$ in memories of both a receiver and a corresponding transmitter before data to be transmitted is transmitted.

24. A method of wireless differential communication, the method comprising:

generating a set, $\mathcal{A}$, of real-valued scalars according to the following equation:

$$d = -\tan(\theta / 2)$$

for every θ in the set {θ} = {π/r, 3π/r, 5 π/r, ... (2r-1) π/r}, where $d \in \mathcal{A}$, r is the number of elements in said $\mathcal{A}$ and $r = 2^{R*M/Q}$, and where R is the rate in bits per channel use, M is the number of transmit antennas, and Q represents the number of degrees of freedom.

25. The method of claim 24, further comprising:

performing at least one of

generating a plurality of baseband signals based on input data encoded as a function of values taken from said $\mathcal{A}$, and

processing a plurality of encoded receive baseband signals to obtain data represented thereby, said receive baseband signals having been encoded as a function of values taken from said $\mathcal{A}$.

26. The method of claim 24, further comprising:

storing said $\mathcal{A}$ in memories of both a receiver and a corresponding transmitter before data to be transmitted is transmitted.

27. An apparatus operable to perform the method of claim 1.

28. A computer-readable medium having code portions embodied thereon that, when read by a processor, cause said processor to perform the method of claim 1.

29. An apparatus operable to perform the method of claim 14.

30. A computer-readable medium having code portions embodied thereon that, when read by a processor, cause said processor to perform the method of claim 14.

31. An apparatus operable to perform the method of claim 21.

32. A computer-readable medium having code portions embodied thereon that, when read by a processor, cause said processor to perform the method of claim 21.

33. An apparatus operable to perform the method of claim 24.

34. A computer-readable medium having code portions embodied thereon that, when read by a processor, cause said processor to perform the method of claim 24.